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only line of greater intensity than 3 which I did not record. Three short iron lines of low intensity which I observed, probably in moments of good seeing, are not given by Young, but two of them occur in Lockyer's table of eclipse lines. The long line of scandium at 5527·03 is probably identical with a line observed by Young, which has been assumed to be the adjacent magnesium line 5528·64 when correcting from the scale of Ångström to that of Rowland. I have seen it on other occasions in metallic prominences, and am quite certain of its position. Notwithstanding the generally higher intensities which I have assigned to the shorter lines as compared with those given by Young, it would thus appear that the spectrum of the disturbed chromosphere is remarkably constant.

A comparison with the flash spectrum, as recorded by prismatic cameras, indicates that the long arcs of the eclipse spectra are represented by long lines in the foregoing table, suggesting that over a spot there is a general elevation of the chromospheric layers with little intermingling.

So far as it is possible to make a comparison of the bright chromospheric lines of February 11 with the affected dark lines previously noted in the spot, it appears that the high level lines were not among those intensified in the spot, while the common lines were chiefly those of iron, chromium, and calcium, which appear as strong Fraunhofer lines.

Addendum, 1905 *March* 13.

Brilliant prominences were again observed in the neighbourhood of the decaying spot when it was near the western limb on the morning of March 10. Many bright lines were seen, and the twenty-one identified were identical with long lines observed on February 11, and had the same relative intensities.

The Seasonal Variation in Magnetic Disturbance, with other Remarks. By William Ellis, F.R.S.

In my paper, *Monthly Notices*, 1899 December, I showed, from the records of the Royal Observatory for the fifty years 1848–97, that there existed greater frequency of magnetic disturbance at Greenwich at or near the equinoxes, and a lesser frequency at or near the solstices; and in again referring to this question, *Monthly Notices*, 1901 June, I said that "the spring maximum appears, on the whole, to fall somewhat before the equinox, and the autumn maximum somewhat after the equinox." I propose now, from the material contained in the first-mentioned paper, to endeavour to locate these points more precisely. At p. 153 of that paper the number of days of moderate, active, and great

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disturbance occurring in the fifty years mentioned are separately given, arranged in half-monthly periods, these three sets of numbers being here combined to form the numbers in Table I. as given by observation; but as fifty years are apparently insufficient to produce uniformity, smoothed values have been added, found by twice taking in succession the means of three observed values.

TABLE I.

Number of Days of Magnetic Disturbance, 1848–97, in Half-monthly Periods.

Middle Day of Half-monthly Period.	Total Number of Days of Moderate, Active, and Great Disturbance: As Observed.	As Smoothed.	Middle Day of Half-monthly Period.	Total Number of Days of Moderate, Active, and Great Disturbance: As Observed.	As Smoothed.
Jan. 1	116	146	July 3	121	127
16	165	163	18	145	136
Feb. 1	184	183	Aug. 2	140	143
16	219	200	17	149	156
Mar. 3	209	204	Sept. 2	162	171
18	189	200	17	209	190
Apr. 2	208	191	Oct. 2	202	197
18	178	176	17	203	197
May 3	155	156	Nov. 1	184	185
18	132	137	17	185	173
June 2	114	125	Dec. 2	139	155
18	119	123	17	156	148

The observed and smoothed values are graphically represented in the annexed diagram. Inspection of the smoothed numbers and smoothed curve alike shows that the points of maximum disturbance fall at about March 3 and October 9 respectively, the former in advance of the spring equinox by about the same number of days as the latter follows the autumn equinox. This close agreement in the interval of time—in the one case preceding the equinox by some seventeen days and in the other following the equinox by some seventeen days—may be, in a sense, accidental; and it will be interesting to see how far this result may afterwards be confirmed. As regards minima, that of summer appears to be much more pronounced than that of winter. The position of the points of maximum frequency of disturbance may possibly vary with the latitude of the place.

I have read with interest the paper by Mr. Maunder in which he endeavours to show the existence of direct relation between the rotation period of the Sun and the occurrence of terrestrial magnetic storms, and Professor Schuster's criticism thereof. Whatever may be the nature of any suggested explanation of their cause, it should satisfy established facts of observation. Perhaps I may be allowed to refer to some of

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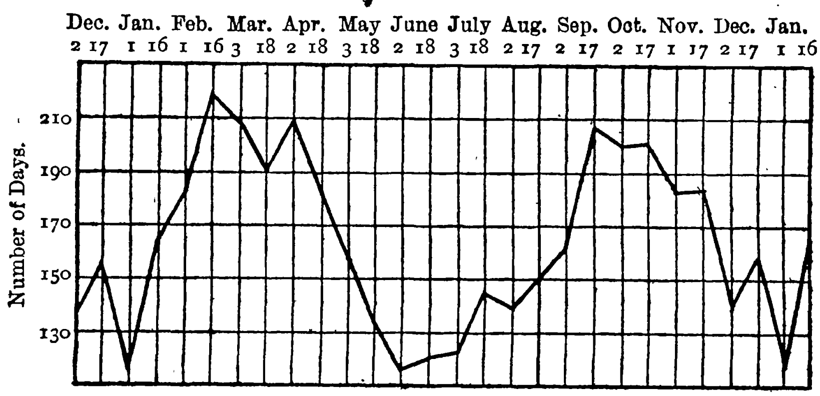
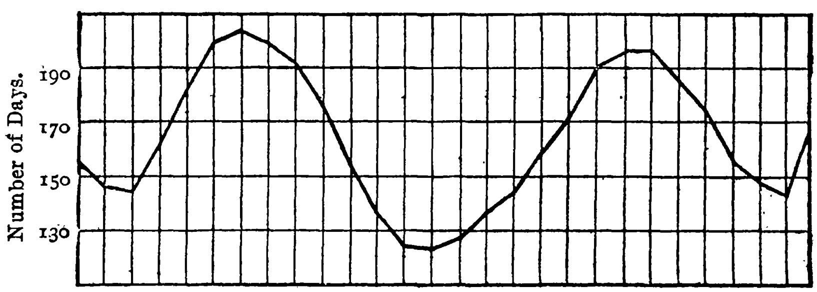
these. One circumstance is that active storms commence simultaneously over the whole earth—an accordance that has been shown to exist at stations widely separated both in latitude and longitude. The first impulse is usually of the nature of a sudden shock, more or less marked, in some cases being of extreme violence. But if the primary cause of magnetic storms be mainly of terrestrial origin, how is the undoubted general relation with sun-spot variation to be explained? Another matter is the already spoken of seasonal variation in the frequency of disturbance existing in our latitude, and by analogy the existence of similar seasonal variation (with maxima at the equinoxes) in southern latitudes, whatever may be the nature of the variation

Seasonal Variation of Magnetic Disturbance.



The above Curve smoothed.



in polar regions. The publication of the results of the reduction of the long series of Melbourne photographs, understood to have been taken in hand, might usefully confirm on this point what has been observed in our latitude.

A further circumstance which may be considered is that the first impulse in a magnetic storm, as well as at times being of considerable magnitude, has a tendency also to be of similar character in different storms, but having at different places its own distinctive character. In Table III., *Proc. Roy. Soc.* vol. lii. p. 205, an attempt was made to give particulars on this point in regard to seventeen separate storms observed at nine different places. The returns made to me were not complete, but at six

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of the places the information is interesting. The particulars are contained in Table II., which indicates that at Greenwich, in

TABLE II

Direction of First Movement in Magnetic Storms.

Place.	Number of Days: on which the Returns were Complete.	Number of Days: on which the First Movement was of Similar Character.	Direction of First Movement in: Dec.	Hor. Force.	Vert. Force.
Greenwich	14	11	+	+	+
Pawlowsk	9	6	+	+	+
Mauritius	11	7	−	+	+
Bombay	17	17	+	+	−
Batavia	15	15	+	+	−
Zi-ka-wei	4	4	−	+	−

eleven out of fourteen cases, and at Pawlowsk, in six out of nine cases, the first movement was such as to increase all elements; that at Mauritius, in seven out of eleven cases, declination was decreased and horizontal and vertical force increased; and that at Bombay and Batavia declination and horizontal force were increased and vertical force decreased for the whole of the instances, seventeen and fifteen respectively, in which the returns were complete. At Zi-ka-wei, in addition to the four cases in which the information was complete, on eleven other days there was indication for either one or two of the magnets, all in harmony with the movements for Zi-ka-wei given in the table. At Melbourne there was no special distinctive movement. These results would appear to be of some importance as showing that at the commencement of a magnetic storm the first impulse is in general similar: that is, that the Earth becomes affected usually in one definite way. This seems rather to raise the question whether the first shock over the whole Earth occurs when any particular face of the Earth is turned to the Sun. As mentioned in my first quoted paper, p. 151, I once tabulated to a considerable extent these initial movements according to the hour of Greenwich time, and remarked (p. 152) that there was some reason to think that storms commence more frequently when the Earth occupied a given position; but the inequality was not very striking—certainly there was no part of the twenty-four hours at which these movements were either unusually numerous or very scarce.

Another matter is that earth-currents (the spontaneous currents that arise in telegraph wires), which at times of quiet magnetism are very weak, become when a magnetic storm arises powerful. The two phenomena are connected in the most striking manner. But a solitary magnetic movement, even if it be not great, only it be sudden or abrupt (the essential feature),

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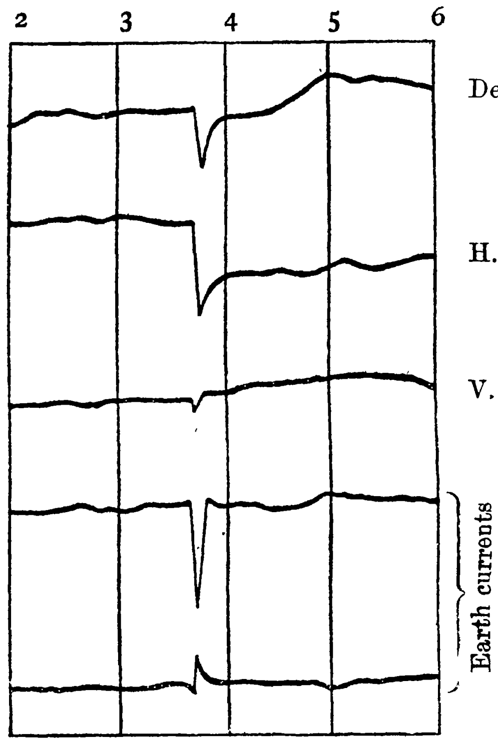
will be at once accompanied by an equally abrupt earth-current. At times isolated instances of this feature arise. An interesting illustration of a case of this kind, showing the close relation that exists on such occasions between magnetic and earth-current movements, is that occurring at Greenwich on 1893 February 14 at $3^h\ 45^m$ in the morning, when the isolated magnetic movements, though not large (in declination only four minutes of arc), were

1893 *February* 14, *Morning.*



Isolated magnetic and earth current movement recorded at Greenwich (copy of photograph).

accompanied by corresponding marked earth-current, the different elements all being in a quiescent state both before and after the little outbreak. It may be further noted that the diagram indicates increase of declination and of horizontal and vertical force, the movements being in this respect in harmony with the usual Greenwich direction of first movement in storms, as shown in Table II.

Provisional Elements of Jupiter's Satellite VI.
By A. C. D. Crommelin.

The information contained in *Publications of the Astronomical Society of the Pacific*, vol. xvii. No. 100, renders it tolerably certain that this object is really a satellite of *Jupiter*. Professor Aitken's visual observation with the 36-inch refractor proves that it is a real body in our system, not a mere series of

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